

REMARKS

Favorable reconsideration of this application in light of the following discussion is respectfully requested.

Claims 1-3 and 7-11 are currently active in this case. Claims 6 and 12-17 have been cancelled by a previous amendment. In the present amendment, Claims 4-5 are cancelled without prejudice or disclaimer.

In the September 8, 2008 Office Action, Claims 4-5 were rejected under 35 U.S.C. § 112, second paragraph, as not further limiting the scope of the preceding claim. Claims 1-5, and 7-11 were rejected under 35 U.S.C. § 102(b) as anticipated by Sato et al. (Japanese Patent Publication JP 2001-093524, hereinafter "Sato"). Alternatively, Claims 1-5 and 7-11 are were rejected under 35 U.S.C. § 103(a) as unpatentable over Zhuang et al. (Publication of the Journal of Alloys and Compounds, "The 673 K isothermal section of the La-Ni-Sn ternary system," Vol. 363, No. 1, January 28, 2004 , pp. 228-231, hereinafter "Zheng") in view of Sato.

In response to rejection of Claims 4-5 under 35 U.S.C. § 112, second paragraph, these claims are herewith cancelled without prejudice or disclaimer.

In response to the rejection of Claim 1 under 35 U.S.C. §§ 102(b) and 103(a), Applicants respectfully traverse the rejections, and request reconsideration thereof, as next discussed.

Briefly summarizing, Applicants' amended independent Claim 1 is directed to a nonaqueous electrolyte secondary battery. The battery includes a positive electrode, a negative electrode including an alloy having a CeNiSi_2 type crystal structure, and a nonaqueous electrolyte. In addition, the alloy has a composition represented by a formula $\text{LnM}_1\text{xM}_2\text{y}$, where Ln denotes at least one kind of element selected from the elements having an atomic radius falling within a range of 1.6×10^{-10} m to 2.2×10^{-10} m, M1 is at least one

element selected from the group consisting of Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, and Nb, M2 is at least one element selected from the group consisting of P, Si, Ge, Sn and Sb, and x and y satisfy the conditions of $0.5 \leq x \leq 1.5$ and $1.5 \leq y \leq 3.5$.

As described in Applicants' specification from page 34, line 16, to page 35, line 6 in non-limiting example, the alloy as described in Claim 1 can be prepared by an induction heating method, and during this heating method, a melt cooling rate needs to be controlled in a range of 10^1 to 10^4 K/s. More examples of the manufacturing process of the alloy are described in Examples 18-31, from page 54, line 22, to page 55, line 4 of Applicants' specification.

Moreover, as explained in Applicants' specification from p. 31, l. 21, to p. 34, l. 10, the alloy that has a CeNiSi₂ type crystal structure and has a composition represented by LnM_{1x}M_{2y}. This features allow to increase the reactivity of the alloy with lithium, and also can improve the discharge capacity of a nonaqueous electrolyte battery. Please note that the above discussion is for explanatory purposes only, and is not intended to limit the scope of the claims.

Turning now to the outstanding rejections, the pending Office Action asserts that Sato teaches the features of Applicants' Claim 1 related to the chemical elements and atomic radiuses. Applicants respectfully disagree with this position and traverses this position, as next discussed.

The reference Sato is directed to active material for non-aqueous electrolyte rechargeable batteries to preserve long life-time of the batteries. (Sato, ¶ [0001], ¶ [0008]). Sato's invention is directed to a material composition that aims to suppress mechanical expansion stress between A phase and B phase pulverized material, that is caused by charge-and-discharge of batteries. (Sato, ¶ [0008], ¶ [0021]). The active materials described in Sato include, as shown in his Tables 1-4, not only A phase and B phase, but also C phase and other

phases in some cases. (Sato, ¶¶ [0039]-[0040].) In the attached copies of Tables 1-4 that are taken from Sato, the columns have been denoted by reference symbols (a) to (i), and a translation from Japanese to English is herewith provided:

- (a) Example Number
- (b) Composition of Active Material
- (c) A phase
- (d) B phase
- (e) C phase
- (f) Other phases
- (g) Initial Discharge Capacity (mAh/g)
- (h) Capacity Maintenance Rate (%)
- (i) Comparative Example Number

a	b	c	d	e	f	g	h
実施例	活性物質組成	A相	B相	C相	その他の相	初回放電容量 (mAh/g)	容量維持率 (%)
1	FeSn	FeSn ₂	FeSn	-	-	750	78
2	Fe _{0.8} Sn	FeSn ₂	FeSn	Sn(7)	-	820	71
3	Fe ₃ Sn ₂	FeSn ₂	FeSn, Fe ₃ Sn	-	-	840	88
4	Fe ₂ Sn	FeSn ₂	FeSn, Fe ₃ Sn	-	Fe	810	94
5	CoSn	CoSn ₂	CoSn	-	-	770	75
6	Co ₂ Sn	CoSn ₂	CoSn	-	Co	830	91
7	CoSn ₂	CoSn ₂	CoSn	Sn(5)	-	880	89
8	MnSn	MnSn ₂	Mn ₂ Sn	-	-	890	81
9	Mn ₂ Sn	MnSn ₂	Mn ₂ Sn, Mn ₃ Sn	-	-	580	94
10	Mn _{2.5} Sn	MnSn ₂	Mn ₂ Sn, Mn ₃ Sn	-	Mn	550	97
11	Mn ₂ Sn ₃	MnSn ₂	Mn ₂ Sn	Sn(8)	-	780	77
12	FeMnSn ₂	FeSn ₂ , MnSn ₂	FeSn, Mn ₂ Sn	-	Fe	740	81
13	ZrSn	ZrSn ₂	Zr ₄ Sn	-	-	700	80
14	KFeSn ₂	KSn ₂	FeSn	-	Fe	830	79
15	LaNi ₂ Sn	LaSn ₂	Ni ₃ Sn ₂ , Ni ₃ Sn	-	-	450	96
16	PdCu ₃ Sn	PdSn ₂	Cu ₃ Sn	-	Cu	440	97
17	NiSn	Ni ₃ Sn ₄	Ni ₃ Sn	Sn(2)	-	520	94
18	Fe ₅ Sn ₂	FeSn	Fe ₃ Sn	Sn(2)	-	480	95
19	KMnSn ₂	KSn	K ₂ Sn, Mn ₃ Sn	-	-	520	87
20	Ti ₃ Sn ₂	Ti ₆ Sn ₅	Ti ₂ Sn, Ti ₃ Sn	-	-	640	89
21	TiSn	Ti ₆ Sn ₅	Ti ₂ Sn	Sn(5)	-	850	81
22	Cu ₃ Sn ₂	Cu ₆ Sn ₅	Cu ₃ Sn	-	-	670	95
23	CuSn	Cu ₆ Sn ₅	Cu ₃ Sn	Sn(6)	-	720	86
24	FeCuSn	Cu ₆ Sn ₅	Cu ₃ Sn, Fe ₆ Sn	-	-	850	82
25	Fe ₂ CuSn	Cu ₆ Sn ₅	Cu ₃ Sn, Fe ₁₂ Sn	-	-	580	87

Table I

	a	b	c	d	e	f	g	h
実施例	活物質組成	A相	B相	C相	その他の相	初回放電容量 (mAh/g)	容量維持率 (%)	
26	Fe ₃ CuSn	Cu ₆ Sn ₅	Cu ₃ Sn	-	Fe ₁₈ Sn	520	93	
27	TiFeSn	Ti ₅ Sn ₅	Ti ₃ Sn, Fe ₈ Sn	-	-	600	91	
28	Ti ₂ Sn	Ti ₂ Sn	Ti ₃ Sn	-	-	630	96	
29	Ti _{1.8} Sn	Ti ₂ Sn	Ti ₃ Sn	Sn(4)	-	590	94	
30	Mg ₂ FeSn ₂	Mg ₂ Sn	Fe ₃ Sn	-	Mg	710	89	
31	KMnSn	K ₂ Sn	Mn ₃ Sn	Sn(3)	-	570	89	
32	CeCu ₂ Sn	Ce ₂ Sn	Cu ₄ Sn	-	-	530	91	
33	CeSi	CeSi ₂	Ce ₂ Si	-	-	740	84	
34	TiSi	TiSi ₂	TiSi, Ti ₅ Si ₃	-	-	710	90	
35	Zr _{0.8} Si	ZrSi ₂	ZrSi	Si(4)	-	700	85	
36	V ₃ Si ₂	VSi ₂	V ₃ Si	-	-	640	89	
37	NbSi	NbSi ₂	Nb ₅ Si ₃	-	Nb	580	91	
38	Mo ₃ Si ₂	MoSi ₂	Mo ₃ Si	-	Mo	620	88	
39	W ₂ Si	WSi ₂	W ₃ Si ₂	-	W	520	94	
40	MnSi	MnSi ₂	MnSi, Mn ₃ Si	-	-	680	87	
41	FeSi	FeSi ₂	FeSi, Fe ₅ Si ₃	Si(1)	Fe	590	94	
42	Fe ₃ Si ₂	FeSi ₂	FeSi, Fe ₃ Si	Si(2)	-	630	92	
43	CoSi	CoSi ₂	CoSi, Co ₂ Si	Si(2)	-	650	88	
44	Co ₃ Si ₂	CoSi ₂	CoSi, Co ₂ Si, Co ₃ Si	-	-	570	93	
45	NiSi	NiSi ₂	NiSi	Si(7)	-	730	76	
46	Ni ₂ Si	NiSi ₂	NiSi, Ni ₃ Si ₂	-	-	510	89	
47	CuSi	CuSi ₂	Cu ₆ Si ₅	-	Cu	660	85	
48	Ti ₂ BaSi ₂	BaSi, TiSi	Ti ₅ Si ₃	-	-	580	87	
49	Ti ₂ Si	TiSi	Ti ₅ Si ₃	Si(4)	-	620	84	
50	Co ₂ Si	CoSi	Co ₂ Si	Si(1)	-	600	89	

Table II

	a	b	c	d	e	f	g	h
実施例	活物質組成		A相	B相	C相	その他の相	初回放電容量 (mAh/g)	容量維持率 (%)
51	Fe ₂ Si		FeSi	Fe ₅ Si ₃	-	-	490	92
52	FeMoSi		FeSi	Mo ₃ Si	Si(2)	-	510	89
53	Mn ₂ Si		MnSi	Mn ₅ Si ₃ , Mn ₂ Si	-	-	480	93
54	PdFeSi		PdSi	Fe ₅ Si ₃	-	Pd	480	91
55	Mn ₃ Si		Mn ₅ Si ₃	Mn ₂ Si	-	-	440	96
56	Co ₃ Si		Co ₂ Si	Co ₃ Si	Si(3)	-	520	93
57	CeCoAl ₃		CeAl ₄ , CeAl ₂	CoAl	-	-	770	75
58	CeAl ₂		CeAl ₂	CeAl, Co ₃ Al ₂	-	-	680	77
59	CuAl ₂		CuAl ₂	CuAl, Cu ₄ Al ₃	-	-	720	75
60	FeAl ₂		FeAl ₃	FeAl	-	-	780	72
61	TiAl ₃		TiAl ₃	TiAl	Al(5)	-	750	78
62	MnAl ₃		MnAl ₄	MnAl	-	-	700	74
63	LaAl ₂		LaAl	La ₃ Al ₂	-	-	620	83
64	FeAl		FeAl	Fe ₃ Al	Al(4)	-	630	84
65	CuAl		CuAl	Cu ₄ Al ₃	Al(3)	-	650	81

Table III

ⁱ 比較例	^b 活物質組成	^c A相	^d B相	^e C相	^f その他の相	^g 初回放電容量 (mAh/g)	^h 容量維持率 (%)
1	Sn	-	-	Sn(100)	-	620	12
2	Al	-	-	Al(100)	-	730	5
3	Cu ₆ Sn ₅	Cu ₆ Sn ₅	-	-	-	550	34
4	FeAl	FeAl	-	-	-	600	29
5	Mg ₂ Ge/Mg	Mg ₂ Ge	-	-	Mg	530	22
6	Mg ₂ Sn/Mg	Mg ₂ Sn	-	-	Mg	490	33
7	Mg ₂ Sn/Sn	Mg ₂ Sn	-	Sn(30)	-	650	20

Table IV

The composition of each of the active materials that are used for phase A and phase B are described in column b of Sato' Tables 1-3, where the composition of material elements are listed. (Sato, ¶ [0039]). The following is a translation from Japanese to English of paragraph [0039] of Sato:

"[Example] Next, the present invention will be described more concretely based on examples, however, this invention is not limited to these examples.

<<Examples 1-65>> Each active material, which has a composition (composition of material elements) shown in Tables 1-3 and includes A phase, B phase, another phase consisting of only elements selected from group (m²) (This phase is denoted as C phase in Tables 1-3. In the column of the C phase, numerals in parentheses represent weight % of C phase in each active material. The same is true for Table 4.), and other phases (In Tables 1-3, the indication "-" in the column of Other Phases is not the one for representing that other phases do not exist. The same holds true for Table 4.), was prepared according to the following procedure. A simple substance of each of the material elements was mixed at a given rate in massive form, in the form of plates or of particles, and casted in an arc melting furnace. The obtained cast was, under an argon atmosphere, converted to the form of spherical particles using a gas atomizing method. At this time, an injection nozzle was 1mmφ in diameter and an injection pressure was 100kgf/cm². The obtained particles were shifted with a 45 micron mesh to obtain active material particles 28μm in average diameter."

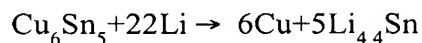
For instance, the active material of Sato's example 12 in Table I, which has a material elements composition of FeMnSn₂, this active material includes five varieties of crystalline phases of FeSn₂, MnSn₂, FeSn, Mn₂Sn and Fe. That is, the active materials described in Sato

each have a plurality of crystal structures represented by A phase, B phase, C phase, and another phases (represented in column f of Sato's Tables 1-4).

Moreover, as described in Sato's paragraphs [0010]-[0019] and [0027]-[0036] and in his Tables 1-3 where material compositions are listed for the phases, each of the above-mentioned phases belongs to a *binary alloy system* or a *single-phase structure* such as Fe phase.

In contrast, the nonaqueous electrolyte secondary battery of Applicants' independent Claim 1 includes a negative electrode including an alloy having a crystal structure of CeNiSi_2 type, and belongs to a ternary alloy system. Sato fails to describe anything related to the CeNiSi_2 -crystal structure. Sato merely mentions in his paragraph [0009] that Ce can be an element of the composition, but fails to describe anything related to a CeNiSi_2 type crystal structure. Therefore, the active materials of Sato do not anticipate the features of Applicants' Claim 1 to recite "a negative electrode including an alloy having a CeNiSi_2 type crystal structure" of Applicants' Claim 1.

Moreover, Sato describes in his paragraph [0021] that "it is considered that this is because the difference between the expansive stress occurring when A phase absorbs lithium and that occurring when B phase absorbs lithium is small, and thus the expansive stress in the whole active material can uniformly be relieved." In other words, Sato teaches that both A phase and the B phase is made of active material that absorbs lithium. In addition, because the A phase and the B phase have a crystal structure of binary alloy system described in paragraphs [0010]-[0019] and [0027]-[0036], and Tables 1-3 of Sato, when lithium is absorbed, a lithium alloy phase is generated. For example, with respect to A phase consisting of Cu_6Sn_5 described in paragraph [0027] of Sato, it is known that a charging reaction occurs, which will be a lithium absorbing reaction, as exemplified by the following reaction formula:



(See also Sato, Table 1, example 22, phase A.) As is clear from the above reaction formula that a lithium alloy phase such as $\text{Li}_{4.4}\text{Sn}$ is newly generated, and Lithium is *not* inserted inside A phase. As explained in Applicants' specification at pp. 52-53, it is well-known that the generation of a lithium alloy LiSn in a charge-discharge stage brings about a substantial change in the volume of an alloy active material. Accordingly, the fine pulverization of the active material can cause a deterioration of the charge-discharge cycle. (See specification, from p. 52, l. 26 to p. 53, l. 4).

In contrast, as explained in Applicants' specification, in the case where a lithium ion is inserted between crystalline layers in a charging stage, no alloying reaction with lithium will occur, and the inserted lithium ion is discharged from between the crystalline layers in a discharge stage. Therefore, in the charge-discharge stage, lithium ion can be inserted or discharged in or from between the crystalline layers without causing an alloying reaction with lithium to occur (See specification, p. 38, l. 22 to p. 39, l. 9). As a fact, Applicants' Figure 1- shows that after the charging and discharging a battery, a diffraction peak from the X-ray that is derived from the presence of the Li-Sn alloy was not observed. (See Fig. 10, specification, p. 60, l. 17 to p. 61, l. 13.)

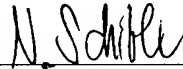
Accordingly, Sato fails to teach explicitly and inherently all the features of Applicants' Claim 1 related to the negative electrode including an alloy having a crystal structure of CeNiSi_2 type. Therefore, Applicants respectfully traverse the rejection under 35 U.S.C. §§ 102(b) and 103(a) based on Sato.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application, and the present application is believed to be in condition for formal Allowance. A Notice of Allowance for Claims 1-3 and 7-11 is earnestly solicited.

Should the Examiner deem that any further action is necessary to place this application in even better form for allowance, the Examiner is encouraged to contact Applicants' undersigned representative at the below listed telephone number.

Respectfully submitted,

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